Regime-Switching Procyclical Government Spending In Developing Countries: An Example Using South Africa

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Abstract

We estimate a Markov switching endogenous government spending rule for South Africa to show the existence of regime dependent cyclicality of fiscal poilicy in developing countries. Estimation results reveal that government spending switches between high and low procyclical spending regimes. we impose the estimated policy rule on a simple neoclassical model to demonstrate how the presence of the regime switching rule impacts the efficacy of government spending shocks. We find that procyclical regime shifts in the government spending rule have both qualitative and quantitative impact on spending multiplier.

JEL Classification:
Keywords: Procyclical government spending, Markov-switching policy rules, Fiscal multiplier, South Africa, Endogenous growth model.

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1 Introduction

In recent decades, several studies have shown that government spending in developing countries is procyclical– government spending as a share in GDP, goes up in booms and down in recessions (e.g. Gavin and Perotti (1997); Talvi and Vegh (2005) Ilzetzki and Végh (2008)).[1] These studies inherently assume that a particular government spending policy persists indefinitely and hence preclude the possibility of regime switching in spending policy driven by either political objectives and/or cyclical economic activities.

This paper estimates Markov switching government spending rule for South Africa to show the existence of regime switching procyclical government spending. Estimation results reveal that government spending is procyclical over the period 1960Q1 to 2017Q1 but switches between "low" and "high" procyclical spending regimes. The high procyclical (HP) regime dominates the pre-apathied period (1960-1993), whereas, the low procyclical (LP) regime dominates the post-apathied regime (1994-2017).

To contextualize the economic implication of the regime-switching rule, we embed the estimated policy rule into a neoclassical growth model. We then study how regime switching procyclical spending affects the efficacy of government spending shocks.[2] More precisely, we compare multipliers generated by the model with the regime switching spending rule (nonlinear model) to multipliers implied by a linear version of the model with a fixed: (i) AR(1) government spending process, (ii) HP spending rule (iii) LP rule.

For the nonlinear, the impact multiplier is the same in both the low and high procyclical regime. However, longer-run multipliers are smaller and attain negative values faster in the LP regime than in the HP regime. Meanwhile the reverse conclusion occurs in the linear models. That is for, all horizons, multipliers implied by the fixed LP spending rule are higher than multipliers from the model with fixed HP spending rule. Finally, the absence of procyclicality and regime switching in the AR(1) allows for larger and positive output multipliers in both the short and long-run.

[1] Several explanations exist for why government spending is procyclical (See for instance, Alesina, Campante, and Tabellini (2008); Abbott and Jones (2013); Akitoby, Clements, Gupta, and Inchauste (2006))

[2] To the best of my, knowledge this is the first paper to account for the possibility of regime switching procyclical government spending policy and their effect on the fiscal multiplier in a developing countries.

The paper is structured as follows. Section 2 provides evidence of regime switching procyclicality by estimating a Markov switching government spending rule for South Africa . Section 3 lays out the model with the different government spending rules, parameter calibration and solution procedures for the models. Section 3 compares numerical results via impulse responses and fiscal multipliers from the models. Section 4 concludes.

2 Evidence of Regime-Dependent Government Spending Rule

To show the existence of regime switching procyclicality, we employ an empirical model specification adapted in Gavin and Perotti (1997), Sutton and Catão (2002), Alesina, Campante, and Tabellini (2008), and Erbil (2011).

$$\Delta g_t = \mu + \gamma(s_t^g)\Delta y_t + \rho(s_t^g)\Delta g_{t-1} + \sigma(s_t^g)\varepsilon_t \tag{1}$$

where g_t is the log real government spending, Δy_t is the output gap, ε_t is an idiosycratic shock to government spending, and s_t^g indicates the spending regime, which follows a Markov chain with transition matrix, P^g whose element is $p_{ij} = Pr[s_t = i, s_{t-1} = j]$. With the exception of the common constant term, μ, all parameters in the other parameters in the model are allowed to assume different values across different regimes. The parameter of interest is γ which measures the type and degree of cyclicality.

Specifically, when $\gamma < 0$ government spending is countercyclical and when $\gamma > 0$ government is procyclical. To distinguish between the degree of cyclicality, we classify a high cyclical regime as when $|\gamma| > 0.5$ and a low cyclical regime $|\gamma| < 0.5$. For instance, if $\gamma = 0.2(-0.2)$, that will be low procyclicality (countercyclicality) while $\gamma = 0.6(-0.6)$ will be indentified as high procyclicality (countercyclicality).

Table 1 reports the MS estimation results for the fiscal rule in Eq.(1). It is clear from the table that with the exception of the common constant term, all estimated parameters are statistically significant at conventional levels. More importantly, the estimated values of γ shows the existence of two distinct reactions of government spending, in terms of magnitude, to changes in the output gap. That is, although in both regimes, γ is

Table 1: (Unrestricted) Markov Switching, government spending rule with two regimes

	$\mu(common)$	ρ	γ	σ	p	q
Regime 1	0.0014 (0.0009)	-0.3985*** (0.0812)	0.7282*** (0.2379)	0.0384*** (0.0646)	0.996 (0.2468)	—
Regime 2	0.0014 (0.0009)	0.6273*** (0.0742)	0.1665* (0.1008)	0.0062 (0.0728)	—	0.995 (0.0603)

Notes: standard deviations in bracket. *,**,***, indicates significance at the 10%, 5%, and 1% conventional levels. p and q are the transition probabilities. The log-likelihood is 594.63 and the SBIC is -5.024

positive, suggesting procyclicality of government spending in South Africa, in regime 1% increase in the output gap elicits a relatively higher increase in government spending (0.73%) compared a 0.12% increase in government spending in regime 2. We can therefore conveniently classify regime 1 as the high procyclical (HP) regime and regime 2 the low procyclical (LP) regime.

Additionally, both regimes are persistent as given by the transition probabilities p and q. The AR(1) coefficient for regime 1 is negative suggesting more cyclicality in government spending. On the other hand, this parameter is positive in regime 2 showing a smoother and medium persistence of government spending.

Figure 1 plots the filtered and smooth probabilities of the HP government spending regime. It is clear from the figure that, regime 1 (HP regime) predominates the periods 1960-1993, whereas, regime 2 (LP regime) predominates the period after 1994. The HP regime between 1960-1993 can be attributed to the poor political environment in the pre-apathied period where there is a high likelihood of political pressures from marginalized groups who demanded increase public spending during booms. Bhorat, Hirsch, Kanbur, and Ncube (2014). Meanwhile, the dominance of the LP regime in the post-apathied period 1994-2017 is consistent with the argument that the dilution in the concentration of power leads to a less procyclical response of government spending (Tornell and Lane (1999)). Moreover, the period after 1994 has been characterized by more prudent and relatively optimal fiscal policies.

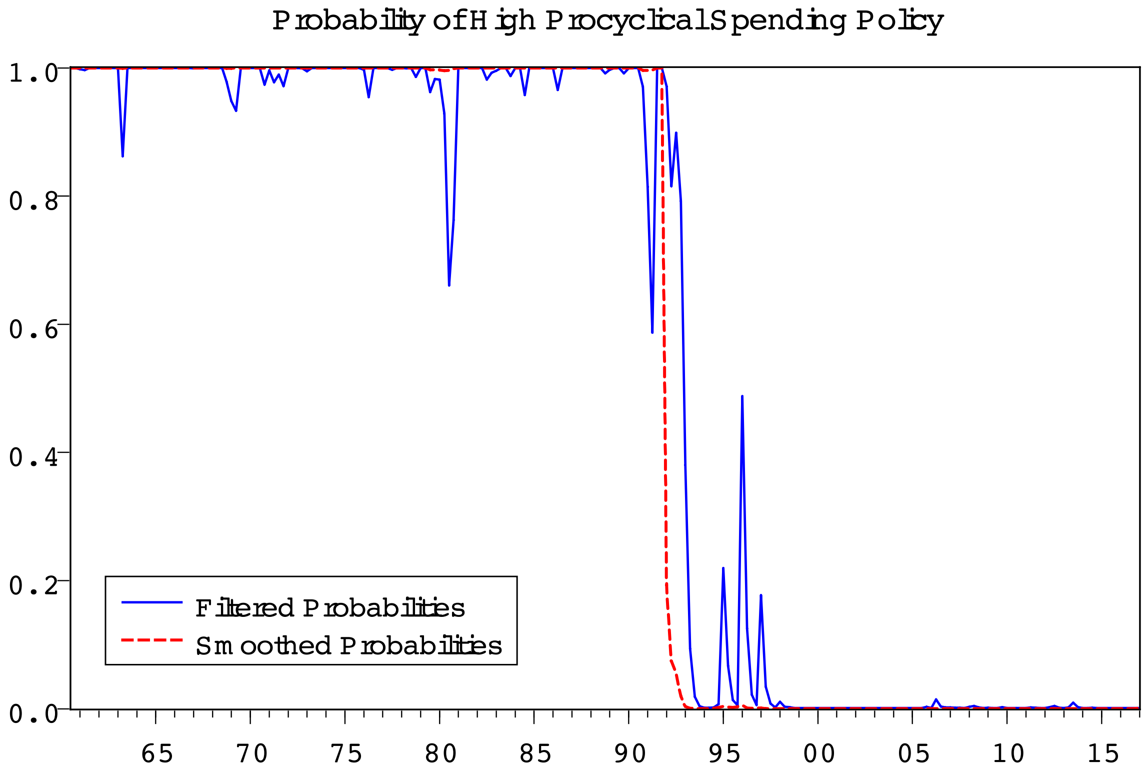

Figure 1: South African Procyclical Government Spending Regimes.

3 Structural Models

3.1 Households: A representative household chooses sequences, $\{c_t, k_t, n_t\}_{t=0}^{\infty}$ to maximize expected lifetime utility, $E_t \sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\sigma}-1}{1-\sigma} - \chi \frac{n_t^{1+\eta}}{1+\eta} \right)$, where $\chi > 0$, β is the subjective discount factor, σ is the coeficient of risk aversion, η is the inverse Frisch elasticity of labor supply, c_t and n_t are consumption and labor hours respectively. The choices are constrained by the period budget set, $c_t + k_{t+1} - (1-\delta)k_t + \tau_t = w_t n_t + r_t^k k_t$, where w_t is the real wage rate, k_t is the capital stock, i_t is investment and τ_t is lump-sum taxes levied on households by the fiscal authority. The optimality conditions for c_t and n_t are as follows:

$$1 = \beta E_t \{ (c_t / c_{t+1})^{\gamma} (r_{t+1}^k + 1 - \delta) \tag{2}$$

$$w_t = \chi n_t^{\eta} c_t^{\gamma} \tag{3}$$

3.2 Firms: A perfectly competitive firms produce output using the constant returns technology, $y = k_t^a n^{1-\alpha}$. This firm chooses $\{n_t, k_t\}$ to maximize profit function, $k_t^a n^{1-\alpha} - w_t n_t - r_t^k k_t$. The first order conditions are as follows:

$$w_t = (1-\alpha) y_t / n_t \tag{4}$$

$$r_t^k = \alpha y_t / k_{t-1} \tag{5}$$

The feasible allocations satisfy the aggregate resource constraint, $g_t + c_t + k_t \leq k_t^a n^{1-\alpha} + (1-\delta)k_{t-1}$

3.3 Government and Fiscal Policy Design: The intertemporal government budget constraint is given as: $\tau_t = g_t$, where g_t and τ_t government spending and lump-sum taxes respectively. We examine the fiscal multiplier in two distinct cases of government spending processes, an AR(1) process of government spending:

Model 1 (AR(1) process): $$\Delta g_t = \rho^{AR}\Delta g_{t-1} + \varepsilon_t^g \quad \text{(6-AR)}$$

Model 2 (Linear, HP): $$\Delta g_t = \rho g_{t-1} + \phi^{FH}\Delta y_t + \varepsilon_t^g \quad \text{(6-FH)}$$

Model 3 (Linear, LP): $$\Delta g_t = \rho \Delta g_{t-1} + \phi^{LP}\Delta y_t + \varepsilon_t^g \quad \text{(6-FL)}$$

Model 4 (R. Switch): $$\Delta g_t = \begin{cases} \rho^{HP}\Delta g_{t-1} + \phi^{HP}\Delta y_t + \varepsilon_t^g, & \text{if} \quad s_t^g = 1 \\ \rho^{LP}\Delta g_{t-1} + \phi^{LP}\Delta y_t + \varepsilon_t^g & \text{if} \quad s_t^g = 2 \end{cases} \quad \text{(6-RP)}$$

Model 1,2 and 3 are the models with fixed policy rules. Specifically, Eq. (6-AR) is the model with conventional AR(1) government spending process, Eq. (6-FH) and Eq.(6-FL) represents the models with high and low linear procyclical government spending rule respectively. Finally, Eq. (6-RP) is the estimated regime switching procyclical rule. To isolate the effect of regime-dependent procyclicality, we assume a common variance in both regimes.

4 Calibration and Solution Strategy

The model explained in section 3 is calibrated to the South African economy at an annual frequency.[3] A fraction of the model paramters and steady state values are calibrated following Liu, Gupta, et al. (2007). The parameters from the estimated procyclical policy rule governs the regime switch government spending policy designed in the model. Table 1 provides the values of the calibrated parameters. Other model parameters and steady state values are model implied and are given in the appendix.

Table 2: Baseline Calibration of the South African Economy

Discount factor	β	0.99	Steady-state gov. spending share	$\bar{g}/\bar{y}$	0.26
Frisch Elasticity of substitution	$1/\eta$	1	Regime 1: Coef. of y_t	ϕ^{HP}	0.7282
Elasticity of Inter. subst.	$1/\sigma$	1	Regime 2: Coef. of y_t	ϕ^{LP}	0.1665
Depreciation rate	δ	0.076	Regime 1: AR(1) Coef. in	ρ^{HP}	0.6273
capital share in outpu	α	0.01	Regime 2: AR(1) Coef. in	ρ^{LP}	-0.3985
Steady-state labor	$\bar{n}$	0.02	Sstd. dev. of g_t rule	σ^g	0.01

[3]Generally, availability of high frequency data for developing countries is scarce. Moreover, the lags involved with fiscal policy implementations makes annual calibration a consistent numerical choice.

The parameter governing the AR(1) process of government spending in model 1, ρ^{AR} is set to 0.9. This is the value usually used in dynamic optimizing models that examine the government spending shocks. Moreover, we solve Model 1, the model with the linear AR(1) process, by log-linearizing the nonlinear system of equations in section 3. The numerical simulations are carried out using *Dynare*. For the Model 2, the model with the estimated government spending rule, we solve the aggregate nonlinear using a policy function iteration algorithm formulated on monotone map method (MMM). The MMM was first used to prove the existence and uniqueness of equilibrium of non-optimal economies by Coleman (1999). Recently, Davig (2004) developed and algorithm to approximate the solutions to regime switching models. The solution method discretizes the state space and iteratively solves for updated policy functions that satisfy the equilibrium system until a specified tolerance is reached.[4][5]

5 Numerical Results

5.1 Linear Models Figure (2) plots the impulse response of selected variables from the linear models with fixed spending rules to a 1 percent increase in government spending. Following an increase in government spending, output rises while consumption and investment fall. These are expected response due to standard wealth effect explained by Baxter and King (1999). Specifically, increase in lump sum taxes to finance the spending makes households feel poorer and substitute away from consumption and leisure by increasing labor hours. This leads to an increase in output. Crowding-out effects drives the fall in investment. Despite the fall in consumption and investment, the strong persistence of the shock in the case of the AR(1) process produces a longer time for output to return to its steady state. This effect keeps output positive even in the longer run.

Note that the AR(1) process does not account for endogenous feedback mechanism from procyclicality. The presence of procyclicality in the fixed HP and LP rule means government spending responds contemperanously in the direction of the output gap. This

[4] Full details of the solution are available in the appendix.

[5] Richter, Throckmorton, and Walker (2014) provide a user friendly toolbox to implement the solution.

generates feedback effects from output to government spending following the shock. Since the shock is not persistent, after output rises when the shock hits the economy, it quickly falls.The fall in output feeds back to the spending rule and causes fiscal authority to cut spending according to the degree of procyclicality. This further puts a downward pressure on output as the cuts directly impacts aggregate demand. This leads output to fall below its steady state. The reduction in government spending also crowds-in investment and leads to a marginal but positive rebound in investment. From this point, the path of government spending back to its steady state is driven by the path of output. The recovery of consumption to its steady state and the positive rebound of investment drives the slow recovery of output to its long-run value. This feedback mechanism is qualitatively present in both Model 2a and Model 2b.

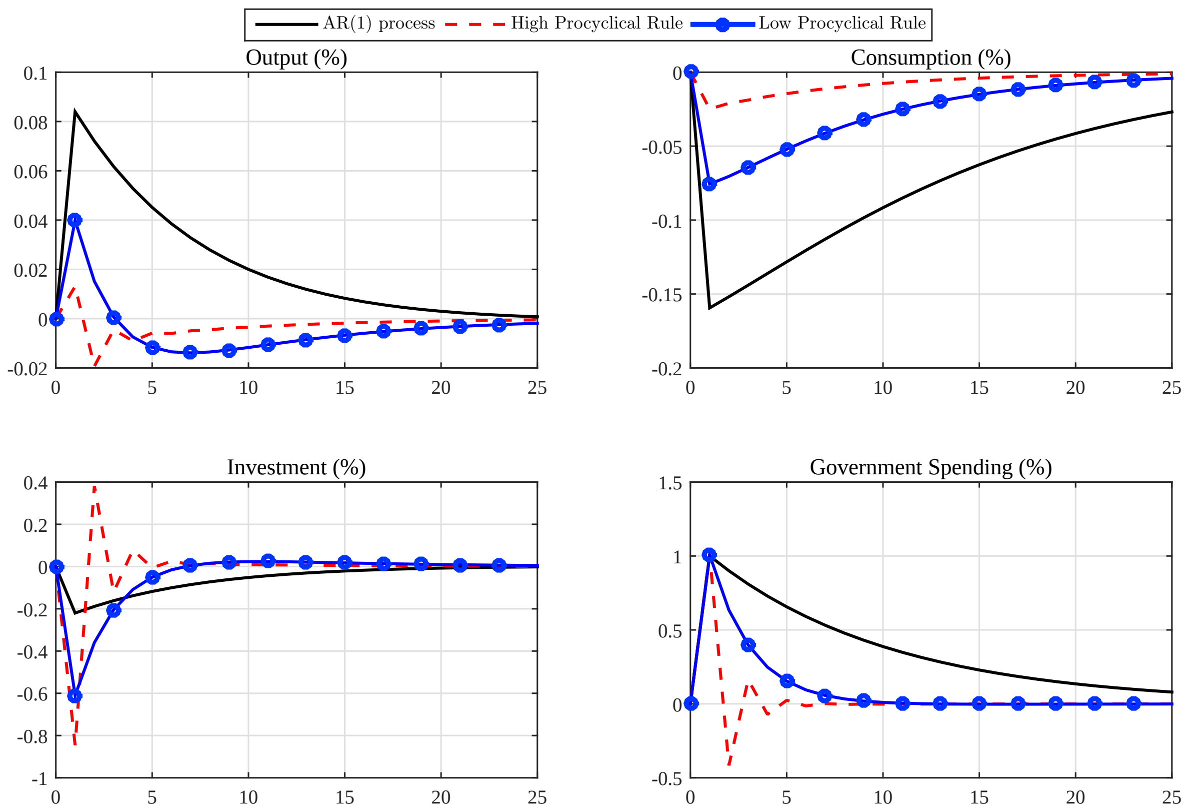

Figure 2: Impulse response function to a 1% increase in government spending with fixed government spending rules.

5.2 Nonlinear Model Figure (3) reports impluse response functions from model 2a and 2b to a 1 percent increase in government spending.

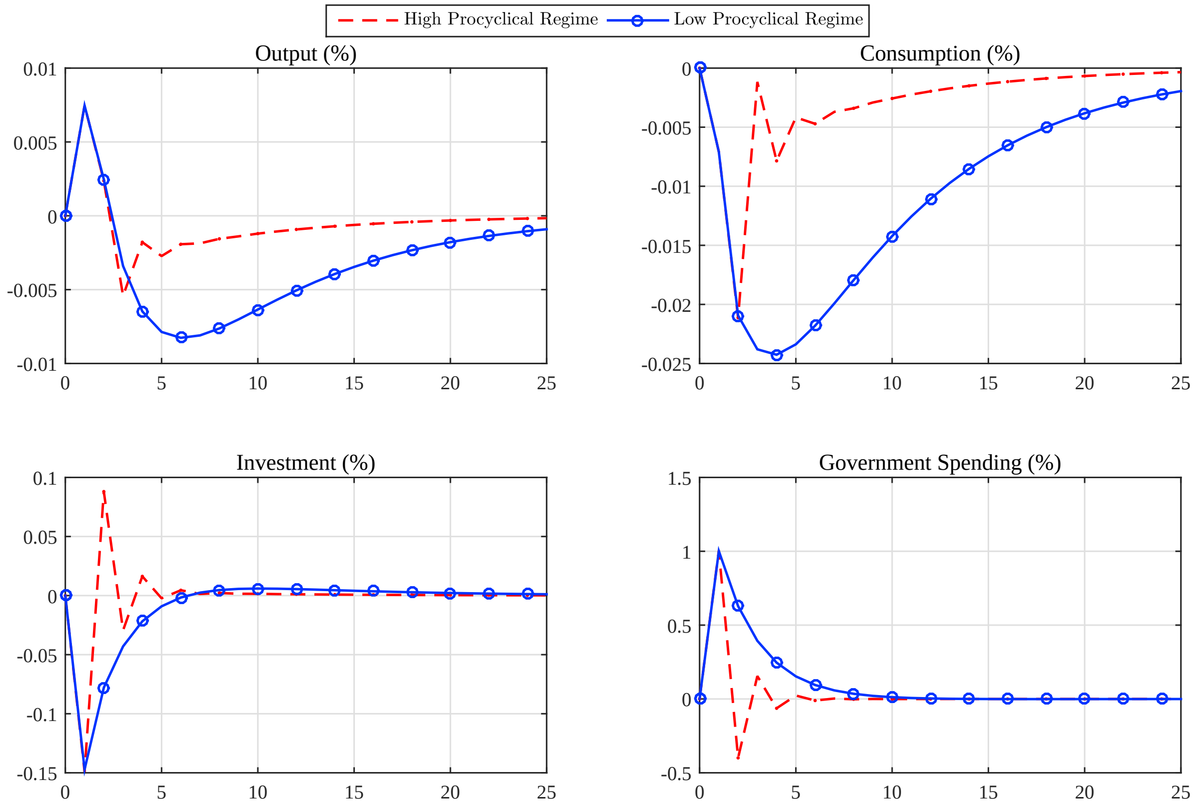

Figure 3: Nonlinear Impulse response function to a 1% increase in government spending with estimated policy rule for government spending.

Recall that, although government spending rule in model 2a and in regime 2 of model 2b are the identical, the latter accounts for possibility of regime switching between low and high procyclical regimes. Meanwhile, the policy rule in model 2a is fixed throughout the business cycle. To appreciate the mechanism present in the modified government spending rules, we compare the impulse response of the macro variables to the government spending shock implied by the fixed procyclical policy rule and the Markov switching policy rule. The black line in figure 2 represent the impulse response from the fixed policy rule and the red and blue lines show the impulse responses from the Markov switching model conditioning on the high and low procyclical regimes respectively.

The negative wealth effect explained earlier in model 1 is also present in model 2a and model 2b. Hence, the observed fall in consumption and the increase in labor and output. However, in addition to the standard wealth effects, the presence of procyclicality and regime switching in the policy rules generates two important features: (i) A feedback effect and (ii) an expectational effects. The feedback effect is due to the presence of procyclicality in the government policy rules and this effect is common to both models (2a and 2b). The expectational effect is only present in model 2b – the Markov switching polic rule.

However, despite the common feedback and wealth effects, from the figure, there is a clear quantitative difference between the impulse responses implied by Model 2a and that of regime 2 of Model 2b. This quantitative discripancy is generated by expectational effects of possible policy changes which is absent in Model 2a. To put the discussion in perspective and to help isolate these expectational effects, we compare the results from Model 2a to the that of regime 2 of Model 2b. As mentioned earlier, both policies are identical because they are both governed by the the same parameter values, particulary the degree of procyclicality $\phi = \phi^{LP} = 0.2653$. However, the possibility of a regime switch in Model 2b from a low to a high procyclical regime means economic agents incorporate expectational effects of switching between regimes in the current decisions.

More precisely, conditioning on regime 2 (low procyclical regime), when government spending shock hits, standard wealth and feedback effects are present. However, the extra effect generated by the expectation of moving to a higher procyclical regime with probabilty $(1 - p_{22})$ means that when output starts falling there is going to be a larger fall in government spending in the high procyclical regime. This also means expectations or the likelihood of larger reductions in taxes. Agents therefore telescope the expected huge fall in taxes to the present which makes them feel optimistic future. The expectation of larger lower taxes offset the negative wealth effects in the current regime leading lower substitution from consumption to labor. Consequently, although labor rises following the shock, the additional expectation effects of lower taxes in the Markov Switching model causes a relatively lower increase in labor compared to the fixed regime counterpart.

This expectational effects is made more evident when we condition on regime 1.

Despite the fact that the degree of procyclicality is very high in regime 1, expectional effects of moving to a low regime causes moderate impacts on the economy compared to the effect of government spending in the fixed regime policy rule in Model 2a represented by the solid black line. In a loose sense, expectational effects generated by the regime switching policy rule can be rationalized as the difference between the solid black line and blue line in figure 2.5.

5.3 Expectational Effects:

We focus on expectational effects from egordic distribution. To be written...

$$\lambda = \frac{1 - p_{11}}{2 - p_{11} - p_{22}}$$

5.4 Multipliers:

To quantify the impact of exogenous changes in government spending, we follow Mountford and Uhlig (2009) and Ilzetzki and Végh (2008) and report cummulative output multipliers computed as:

$$\text{Present value multiplier}, M_Y = \frac{\sum_{j=0}^{k}(1+i)^{-j}\Delta Y_{t+j}}{\sum_{j=0}^{k}(1+i)^{-j}\Delta G_{t+j}}$$

where i is the steadystate interest rate. Note that $(1+i)^{-j}$ is the discount rate and in the model it is equal to $\beta = (1+i)^{-1}$. Table 2 reports the present value multipliers over different horizons. At horizon 1, the impact and the present value multipliers coincide by definition.

Table 3: Output Multiplier: $PV\frac{\Delta Y}{\Delta G}$

Model	Impact	4 qtr	10 qtr	25 qtr
Linear Models				
Model 1: AR(1) process	0.32	0.31	0.28	0.26
Model 2: Fixed High procyclical policy	0.05	-0.01	-0.08	-0.15
Model 3: Fixed Low procyclical policy	0.15	0.10	0.04	-0.01
Nonlinear Model				
Model 4: high procyclical Regime	0.03	0.01	-0.01	-0.02
Model 4: Low procyclical Regime	0.03	-0.01	-0.04	-0.06

6 Conclusion

This paper assess the existence of government spending regime shifts by estimating a Markov switching procyclical fiscal rule for South Africa. Estimation results show that government spending switches between low and high procyclical spending regimes. Imposing the estimated policy rule on an endogenous growth model to study exogenous govenment spending shocks reveal that precluding procyclical regime shifts in government spending rule can have both qualitative and quantitative impact on the spending multiplier.

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